Title: Linear Algebra

Code Number: NS2104

Credit Hours: 3 (3+0)

Prerequisites: Nil

Semester: 3rd

Course Objectives

The course will enable students to:

1. Comprehend basic concepts of Linear Algebra and optimization
2. Apply techniques of Linear Algebra and optimization for solution of engineering problem.

Contents

Unit 1: System of Linear Equations and Applications

1. Overview of linear system of equations
2. Cases of unique solution
3. No solution and infinite solutions
4. Echelon form
5. Gauss elimination method
6. Inversion of matrix in the context of solution of system of equations
7. LU factorization
8. Row space and column space
9. Relevant engineering case studies such as Network analysis
10. Traffic Flows
11. Balancing chemical reaction
12. Leontief Input-output model
13. Finding max stress in compound cylinder
14. Applications of linear systems in force balancing of structures
15. Markov process

Unit 2: Vector Spaces and Transformations

1. Vector Spaces: Real vector spaces
2. Subspaces
3. Basis and dimension
4. Rank
5. Nullity
6. Gram-Schmidt process for finding orthonormal basis
7. Linear Transformation
8. Kernel of Transformation
9. Range of Transformation
10. Matrix of Transformation
11. Applications: Cryptography
12. Coding and decoding
13. Breaking of codes
14. Robotic Applications of linear transformations

Unit 3: Eigenvalues and Eigen Vectors

1. Eigenvalues
2. Eigenvectors
3. Similar matrices
4. Diagonalization
5. Quadratic forms
6. Positive definite Matrices
7. Singular Value Decomposition
8. Inner product Spaces
9. Applications of linear Algebra
10. Constructing curves and surfaces
11. Computer graphics
12. Genetics

Unit 4: Linear Programming

1. Solution Introduction to linear programming
2. Optimization
3. Graphical method
4. Simplex method
5. Optimization problems in engineering and economics
6. Dual simplex methods
7. Duality theory
8. Primal and dual problems
9. transportation models
10. north-west corner
11. least-cost and Vogel's approximations methods
12. Assignment model
13. the transshipment model and other relevant engineering case studies

Unit 5: Application of Linear Algebra in Dynamical Systems

1. Numerical System of linear ODEs
2. Eigenvalue problems
3. Homogeneous and nonhomogeneous system of ODE
4. Dynamical systems
5. Population dynamics
6. Prey-Predator models
7. Stability analysis

Teaching-Learning Strategies:

The pedagogical approach to this course relies on face-to-face teaching in a university classroom environment. The lectures are delivered using multimedia support and on white board. Students are engaged and encouraged to solve real world problems using computer-aided tools.

Assignments/Types and Number with calendar:

A minimum of four assignments to be submitted before the written exams for each term.

Assessment and Examinations:

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2.	Sessional Assessment	25%	It is continuous assessment. It includes classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

Recommended Books:

1. Introductory Linear Algebra: By Bernard Kolman and David R. Hill, Latest Edition.
2. Elementary Linear Algebra: By Howard Anton and Chris Rorrers, Latest Edition.
3. Strang, Gilbert. "Introduction to Linear Algebra." Wellesley, MA: Cambridge Press, (5^{th} Edition) 2016.
4. Lay, David C., Steven R. Lay, and Judith McDonald. "Linear Algebra and Its Applications." Boston: Pearson, 2020.
5. Strang, Gilbert. "Linear Algebra and Its Applications." Belmont, CA: Thomson, Brooks/Cole, 2006.